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J.J. Vasterling, S.P. Proctor, M.J. Friedman, C.W. Hoge, T. Heeren, L.A. King, D.W. King

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Natick, MA 01760-5007

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14. ABSTRACT

Posttraumatic stress disorder (PTSD) has been identified as a significant public health consequence of war. The paucity of prospective research and inclusion of appropriate comparison samples, however, has complicated casual interferences regarding war-zone deployment and PTSD. Enhanced understanding of causal relationships between war and PTSD will help guide healthcare policy. We assessed 779 U.S. Army Soldiers before and after Iraq deployment and compared them with 315 Soldiers similar in military characteristics who did not deploy. PTSD symptom severity and questionnaire-derived screening diagnoses were measured as outcomes. We additionally measured lifetime, war-zone, homefront, and post-deployment stress exposures. Deployment was associated with greater PTSD severity (B=3.61;P<0.001) and almost a threefold higher risk of developing PTSD (OR=2.97, CI=2.56,3.46). PTSD cases among deployed Soldiers increased from 7.6% before deployment to 12.1% following deployment. Although PTSD did not differ significantly at post-deployment between National Guard and active duty Soldiers, PTSD increased more among national Guard Soldiers who reported fewer PTSD symptoms prior to deployment than active duty Soldiers. War-zone events, homefront concerns, and post-deployment life events were associated with outcomes among all deployed Soldiers, but post-deployment life events had greater impact on National Guard as compared with active duty Soldiers. This study provides stronger evidence than previously possible that war-zone deployment is associated with increased risk of PTSD. Findings also highlight the impact of homefront and post-deployment life events in addition to war-zone stress exposures, and emphasize the importance of continued attention to the concerns of reservists.

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PTSD Symptom Increases in Iraq-Deployed Soldiers: Comparison With Nondeployed Soldiers and Associations With Baseline Symptoms, Deployment Experiences, and Postdeployment Stress

Jennifer J. Vasterling
VA National Center for PTSD, VA Boston Healthcare System, and Department of Psychiatry, Boston University School of Medicine, Boston, MA

Susan P. Proctor
VA National Center for PTSD, VA Boston Healthcare System, Boston, U.S. Army Research Institute of Environmental Medicine, Natick, and Department of Environmental Health, Boston University School of Public Health, Boston, MA

Matthew J. Friedman
VA National Center for PTSD, White River Junction, VT, and Departments of Psychiatry and Pharmacology, Dartmouth Medical School, Hanover, NH

Charles W. Hoge
Department of Psychiatry and Behavioral Sciences, Walter Reed Army Institute of Research, US Army Medical Research and Materiel Command, Silver Spring, MD

Timothy Heeren
Department of Biostatistics, Boston University School of Public Health, Boston, MA

Lynda A. King and Daniel W. King
VA National Center for PTSD, VA Boston Healthcare System, and Department of Psychology, Boston University, Boston, MA

This prospective study examined: (a) the effects of Iraq War deployment versus non-deployment on pre- to postdeployment change in PTSD symptoms and (b) among deployed soldiers, associations of deployment/postdeployment stress exposures and baseline PTSD symptoms with PTSD symptom change. Seven hundred seventy-four U.S. Army soldiers completed self-report measures of stress exposure and PTSD symptom severity before and after Iraq deployment and were compared with 309 soldiers who did not deploy. Deployed soldiers, compared with non-deployed soldiers, reported increased PTSD symptom severity from Time 1 to Time 2. After controlling for baseline symptoms, deployment-related stressors contributed to longitudinal increases in PTSD symptoms. Combat severity was more strongly associated with symptom increases among active duty soldiers with higher baseline PTSD symptoms.

The estimated prevalence of posttraumatic stress disorder (PTSD) among U.S. Iraq War veterans exceeds 12% among recently returned service members (Hoge et al., 2004) and 16% in soldiers assessed one year after return from Iraq (Hoge & Castro, 2006). Combined samples of U.S. service members deployed to Iraq or Afghanistan revealed estimated PTSD rates of 14% (Tanielian & Jaycox, 2008), with new onset cases exceeding 7% among combat-exposed personnel (Smith et al., 2008), and are consistent with mental health outcomes observed after previous wars (Dohrenwend et al., 2006; Kulka et al., 1990; Toomey et al., 2007). Attributes of deployment associated with PTSD include combat (Hoge et al., 2004), war-zone threat appraisals (Iversen et al., 2008), and noncombat deployment stressors (King, King, Foy, Keane, & Fairbank, 1999; King, King, Bolton, Knight, & Vogt, 2008). In addition, prior trauma exposure (Iversen et al., 2008; Smith et al., 2008) has been associated with increased risk of PTSD following combat. These studies represent a vast literature providing converging evidence of increased PTSD rates following war-zone deployment. With rare exception, however, PTSD deployment studies have not included prospective assessment of PTSD prior to deployment and therefore do not permit consideration of preexisting symptoms.

Understanding how predeployment PTSD symptoms interact with subsequent deployment-related stressors is particularly relevant in the context of repeated war-zone deployments for service members. High rates of baseline PTSD symptoms even among first-time deployers (Brailey, Vasterling, Proctor, Constans, & Friedman, 2007) underscore the significance of this question to contemporary war-fighters and highlight the scientific importance of baseline measurement. As demonstrated by a small number of prospective studies assessing PTSD symptoms prior to subsequent trauma exposure, preexisting PTSD symptoms may influence PTSD following deployment and other trauma exposures.

In a study assessing military personnel at regular intervals over time, over 43% of deployed Iraq/Afghanistan combat-exposed U.S. service members with baseline PTSD symptoms maintained symptoms following deployment (Smith et al., 2008). UK service members with PTSD subsequent to Iraq deployment were also more likely to have screened positive for PTSD prior to deployment (Rona et al., 2009). The conditional risk for PTSD following civilian trauma exposure was over three times higher among individuals with preexisting PTSD compared with civilians not previously exposed to trauma (Breslau, Peterson, & Schultz, 2008). With the exception of Rona et al. (2009), however, these studies were not designed around an index trauma event (including deployment) and therefore varied considerably regarding the timing of assessments in relation to stress exposures, likely varying in the extent to which factors unrelated to the index trauma influenced outcomes.

The Neurocognition Deployment Health Study was designed specifically around military deployment to Iraq and included baseline and post-war-zone assessments of Iraq-deployed and nonde-ployed Army soldiers, avoiding some of the retrospective reporting biases inherent to cross-sectional studies without preexposure assessments while maintaining a relatively constrained timeframe in reference to the index deployment. Our primary objectives were to (a) determine whether PTSD symptom levels changed as a function of Iraq deployment and (b) examine the associations of preexisting PTSD symptoms and deployment-related stressors with pre- to postdeployment change in PTSD symptoms. Reservists represent a significant proportion of deployed military personnel, but debate continues regarding whether part-time service members have unique concerns that influence mental health outcomes following deployment. As a secondary objective, we examined associations among stress exposures, baseline PTSD symptoms, and change in PTSD symptoms separately within deployed regular active duty and deployed activated National Guard components.

METHOD

Participants

The target population was male and female U.S. Army regular active duty and activated National Guard soldiers serving April 2003 through September 2006. The study included assessment of Iraq-deployed and nondeployed soldiers across two sessions (Times 1 and 2), corresponding to pre- and postdeployment assessments for deployers. Participants were categorized as deployers or nondeployers at Time 2 by their deployment status between Times 1 and 2. Nondeploying units were assessed at times as close as possible to deploying units. At Time 1, most participants, regardless of future deployment status, were functioning under increased demands secondary to anticipated deployment or imminent intensive desert training and were preparing for at least temporary geographic relocation and separation from family and friends.

Sampling was conducted at the military battalion level. To capture heterogeneous deployment experiences and location assignments within the war zone, deploying and nondeploying regular active duty units were selected to represent combat arms (e.g., infantry), combat support (e.g., combat engineers), and service support functions (e.g., supply clerks). Deploying and nondeploying units were well matched in these attributes. All National Guard units deployed and represented primarily combat arms/combat support functions. Deploying and nondeploying units differed in their deployment status during the study as a function of planned deployment rotation schedules. ("Nondeployed" units deployed subsequent to Time 2 data collection.) Within each battalion, unit leaders were asked to refer potential participants at random (e.g., every third name on the unit roster) to facilitate a sample representative of the originating battalion.

At enrollment, 94% of 1633 invited soldiers volunteered participation. Of the 1542 soldiers assessed at Time 1, 73% ($n = 1124$) participated in onsite assessment at Time 2. Soldiers most commonly were excluded from Time 2 assessment because they were

no longer with their originating unit (48% relocated to another unit, 24% separated from service, 5% for unknown reasons). Only 2% declined Time 2 participation. Forty-one participants were excluded for invalid or incomplete questionnaire responses. In the final sample of 1083 participants, 774 participants (670 regular active duty; 104 National Guard) were categorized as deploying and 309 (regular active duty) as nondeploying. All but 26 deployers (22 regular active duty; 4 National Guard) with known dates of return ($n = 766$) served a 12-month Iraq rotation.

Postdeployment assessments for soldiers serving full tours occurred an average of 73.5 days ($SD = 19.5$ days; $Mdn = 75$ days) for active duty soldiers ($n = 641$) and 197.5 days ($SD = 34.0$ days; $Mdn = 189$ days) for National Guard soldiers ($n = 99$) from each participant's return from Iraq. Longer intervals for National Guard soldiers reflected unit-level scheduling constraints.

Measures

Demographic and military information was queried via interview and written surveys and verified by service records. Stress exposures and PTSD symptoms were queried by written questionnaires.

Deployment-related stress exposures were quantified by a modified version of the Deployment Risk and Resilience Inventory (DRRI; King, King, Vogt, Knight, & Samper, 2006), a modular survey. Validation studies have demonstrated high internal consistency (King, King, Vogt, et al., 2006; Vogt et al., 2008), acceptable test-retest reliability (King, King, Vogt, et al., 2006), and strong support for criterion-related and discriminant validity (King, King, Vogt, et al., 2006: Vogt et al., 2008). For deployers, we selected modules assessing stressor categories with documented relationships to mental health outcomes in combat veterans (Dohrenwend et al., 2006; Hoge et al., 2004; King et al., 2008; Kulka et al., 1990) and that corresponded to events occurring chronologically between Times 1 and 2. The DRRI modules administered at Time 2 reflect exposures relevant to war-related stress outcomes, including traditional combat (combat experiences) and noncombat war-zone experiences (postbattle experiences); perceived war-zone threat (deployment concerns); homefront stressors experienced during deployment (life and family concerns); and postwar stressors (postdeployment life events). To characterize the entire sample of both deployers and nondeployers, we administered the DRRI Life Events module at baseline to all participants. This module measured historical exposure to stressful life events.

The PTSD Checklist, Civilian version (PCL-C; Weathers, Litz, Herman, Huska, & Keane, 1993) measures distress levels associated with each PTSD symptom according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition-Text Revision* (*DSM-IV-TR*; American Psychiatric Association, 2000). Respondents rate each item on a 5-point scale, yielding a summary score (range = 17–85) indicative of symptom severity. The PCL has high test-retest reliability ($rs = .92$ and $.88$, immediate and 1-week retest, respectively), internal consistency ($\alpha = .94$), and convergent validity ($rs > .75$) with other PTSD measures (Ruggiero, Del Ben, Scotti, & Rabalais, 2003).

Our central outcome was pre- to postdeployment change in PTSD symptom severity, measured by the PCL summary score. Although difference scores have been criticized as unreliable, recent evaluation of their use as an index of individual change suggests that they are considerably more reliable than formerly assumed, reflecting true dispersion in rates of change across individuals and therefore serving as a desirable tool with which to assess individual differences in change (King, King, McArdle, et al., 2006). As a sample descriptor, we also used the PCL to estimate PTSD "caseness." Screening cases required *DSM-IV-TR* symptom congruency and a cutoff score of ≥ 50. Although Bliese et al. (2008) found that a cutoff of 50 may not be optimal for routine postdeployment screening in Iraq War veterans, our cutoff of 50 permits comparison with prior epidemiological studies of Iraq deployment (Hoge et al., 2004; Hotopf et al., 2006; Rona, Fear, Hull, & Wessely, 2007; Smith et al., 2008). The cutoff also takes into account the baseline assessment, when the true prevalence of PTSD would be expected to be lower (Terhahkopian, Sinaii, Engel, Schnurr, & Hoge, 2008).

Procedure

Written surveys were conducted in small groups at military installations as part of a larger study targeting neurocognitive functioning (Vasterling et al., 2006).

Data Analysis

Missing values for specific items (occurring in <4% of the sample) were replaced for the PCL only if greater than 50% of the items on the entire PCL were completed and greater than 50% of the items relevant to each *DSM-IV-TR* PTSD symptom cluster were completed. The greatest number of items missed for any given case was 5 of a possible 17. Each missing value was replaced by the mean value of the individual's completed items within the *DSM-IV-TR* symptom cluster relevant to that item.

Sample characteristics and differences between Time 2 participants and nonparticipants. Differences in baseline characteristics between deployers and nondeployers and between Time 2 participants and nonparticipants were examined via *t* test or chi-square, as appropriate.

PTSD symptom change and deployment. Because individual participants were nested within battalions, we first examined correlations in responses among participants from the same battalions. Because the within unit correlation was extremely low (intraclass

correlation = −0.003, *ns*), we dropped battalion membership from further consideration. We then conducted a multiple regression with simultaneous entry to assess the effects of deployment on change in symptom severity. Deployment status served as the independent variable; change in PTSD symptom severity served as the dependent variable. To account for baseline PTSD severity, Time 1 PCL was entered as a covariate. Covariates also included age, years of education, and gender.

Because we were unable to identify an appropriate nondeployed National Guard comparison sample, we did not include duty status (regular active duty vs. National Guard) in the regression model. To describe longitudinal change in symptom severity within each deployed duty status subset (regular active duty, National Guard), PCL summary scores at Times 1 and 2 were compared using a paired *t* test. Student's *t*-test statistics compared pre- to postdeployment PCL change scores between groups (deployed vs. nondeployed; regular active duty vs. National Guard).

Predeployment PTSD symptoms, stress exposures, and PTSD symptom change. Associations between preexisting PTSD symptoms, stress exposure measures, and longitudinal change in PTSD symptom severity in deployers were examined separately, using hierarchical multiple regression, in regular active duty and National Guard subsets to determine whether relevant predictive factors differed according to duty status. Correlations in responses among participants from the same battalions were again weak for both active duty (ICC = 0.0052, *ns*) and National Guard (ICC = −0.0126, *ns*) subsets. Unit membership was therefore dropped from further consideration. Within the regression analyses, the order of entry reflected our desire first to control for demographic variables, next to understand the influence of preexisting symptoms, and finally to assess the contributions of deployment stressors after accounting for preexisting symptoms. The order of stressor categories in part reflected chronology (deployment preceding postdeployment). Demographic covariates (age, gender, education for regular active duty; age, education for National Guard) were entered as Step 1, Time 1 (predeployment) PCL as Step 2, war-zone stressors and perceived war-zone threat (DRRI combat, postbattle experiences, deployment concerns) as Step 3, homefront stressors (DRRI life and family concerns) as Step 4, and, DRRI postdeployment life events as Step 5. To examine the unique contributions of war-zone stressors to PTSD change with all other variables accounted for, we repeated the analyses with war-zone stressors and perceived threat entered in a single step subsequent to homefront and postdeployment stressors.

Interactions between baseline PTSD symptom severity and stress exposures were then modeled, with each interaction effect (Time 1 PCL by a single stressor) examined separately. Demographic covariates, Time 1 PCL, and all stressors were entered into the regression first, with the interaction term entered in a subsequent step.

RESULTS

Time 2 participants in the final sample did not differ (at Time 1) from Time 2 nonparticipants in ethnic minority or marital status, PTSD screening caseness, prior stressful life events, use of prescribed psychoactive medications, or psychiatric/alcohol use disorder history. However, nonparticipants scored higher on the PCL (*M* = 30.8, *SD* = 14.0 vs. *M* = 28.9, *SD* = 12.5) *p* < .05, were older (*M* = 26.5 years, *SD* = 7.0 years vs. *M* = 25.5 years, *SD* = 5.7 years) *p* < .01, and were more likely officers (6% vs. 2%) *p* = .001, women (16% vs. 8%) *p* < .001, and to have deployed previously (29% vs. 11%) *p* < .001.

Sample Characteristics, Time 1

Participants (Table 1) generally reflected the deployed U.S. Army population at the time of study enrollment, although women and commissioned officers were underrepresented. During study enrollment, women comprised 9% of the regular active duty and 6% of the National Guard deployed Army forces (vs. 8% of regular active duty and 0% National Guard women in our sample); 13% of regular active duty and 10% of National Guard Army soldiers serving overseas were commissioned officers (vs. 2% commissioned officers in our sample). Deployed and nondeployed participants did not differ on most baseline variables; however, deployers served longer in the Army and were slightly older than nondeployers. Compared with deployers, nondeployers reported more historical stressful life events and more PTSD symptoms at baseline.

Among deployers, National Guard participants were older, served longer in the Army, and were more likely to be married than regular active duty participants, reflecting common differences between regular active duty members and reservists (Table 1). National Guard participants also reported lower baseline PTSD symptom levels than regular active duty participants. Some regular active duty units were mixed gender; National Guard units were all male.

PTSD Symptom Change and Deployment

Multiple regression revealed a significant deployment effect on PCL change scores, with the adjusted change score 3.65 points higher, on average, for deployed versus nondeployed soldiers (Table 3). Follow-up tests revealed significant increases in mean PCL scores from Time 1 to Time 2 (pre- to postdeployment) within the overall group of deployed soldiers, *t*(773) = 8.29, *p* < .001, and within regular active duty, *t*(669) = 6.68, *p* < .001, and National Guard deployed, *t*(103) = 5.87, *p* < .001, subsets. Pre- and postdeployment PCL scores did not differ significantly in nondeployed soldiers, *t* < 1. Among deployers, compared with regular active duty soldiers, National Guard soldiers showed a larger mean change (increase) in PCL summary scores from pre- to

Table 1. Demographic and Contextual Sample Characteristics at Time 1 of Full Sample, Nondeployed, Deployed, Deployed Active Duty, and Deployed National Guard Participants

Variable	Nondeployed (n = 309) M, %	SD	Deployed (n = 774) M, %	SD	Nondeployed vs. deployed[a] t, χ^2	Active duty (n = 670) M, %	SD	National Guard (n = 104) M, %	SD	Active duty vs. National Guard[b] t, χ^2
Age, years, *M, SD*	24.9	5.1	25.7	5.9	−2.11*	25.0	5.2	30.0	8.1	−6.11
Self-reported ethnic minority, %	34.6		39.0		1.79	44.0		6.7		52.64
Women, %	9.7		7.1		2.07	8.2		0		9.19
Education, years, *M, SD*	12.5	1.3	12.5	1.3	0.69	12.4	1.3	12.7	1.7	−1.57
Time in Army, years, *M, SD*	3.9	3.8	4.6	4.8	−2.64	4.1	4.2	8.4	6.6	−6.45
Rank (enlisted), %	97.7		97.8		0.01	97.9		97.1		0.26
Junior enlisted (E1–E4), %	75.4		72.0			73.7		62.5		
NCO (E5–E9), %	22.5		25.6			24.2		34.6		
Officers (commissioned or warrant), %	2.3		2.2			2.1		2.9		
Previous operational deployment (any), %	12.7		10.9		0.64	11.1		9.6		0.20
Since 2001, %	4.4		2.6			2.7		1.9		
OIF/OEF, %	2.2		1.3			1.3		1.0		
Married, %	47.6		46.6		0.10	44.9		56.7		5.04*
Reported prescribed psychoactive or anticonvulsant medication use, past 48 hours, %	1.3		2.2		0.95	1.9		3.8		1.52
Reported psychiatric history (lifetime), %	6.2		6.4		0.02	6.2		7.7		0.32
Reported alcohol use disorder history (lifetime), %	3.6		4.2		0.20	4.4		2.9		0.48
DRRI Early Live Events, No. of events, *M, SD*	5.5	3.5	4.6	3.3	3.61***	4.6	3.3	4.9	3.5	−0.81
PTSD screening "cases", %	12.0		7.6		5.18	8.4		2.9		3.83
PCL summary score, *M, SD*	29.7	13.5	28.6	12.2	1.24	29.2	12.5	25.2	8.9	3.99

Note. D = Deployed; ND = nondeployed; AD = active duty; NG = National Guard; NCO = noncommissioned officers; OIF = Operation Iraqi Freedom; OEF = Operation Enduring Freedom; DRRI = Deployment Risk and Resilience Inventory. The sample size varies slightly across observations due to missing data. *P* values are reported for Fischer's exact test, when appropriate. The most prevalent enlisted military occupational categories were infantry/gun crew (35.9%), communication/intelligence (19.6%), electrical/mechanical equipment repair (12.8%), and service supply (8.8%).
[a]Significance level for deployed vs. nondeployed comparison. [b]Significance level for active duty vs. National Guard comparison within the deployed subset.
*p < .05. **p < .01. ***p < .001.

postdeployment, $t(772) = 2.83$, $p = .005$. At Time 2, 11% of nondeployers and 12% of deployers (12% of regular active duty deployers; 14% of National Guard deployers) screened positive for PTSD caseness.

To address the possibility that greater symptom increases among National Guard soldiers were attributable to their relatively longer interval from Iraq return to post-deployment assessment, we examined correlations between interval duration and PCL change within regular active duty and National Guard deployed subsets. The correlations were weak, failing to reach statistical significance for either regular active duty, $r(661) = -.01$, *ns*, or National Guard, $r(101) = .16$, *ns*.
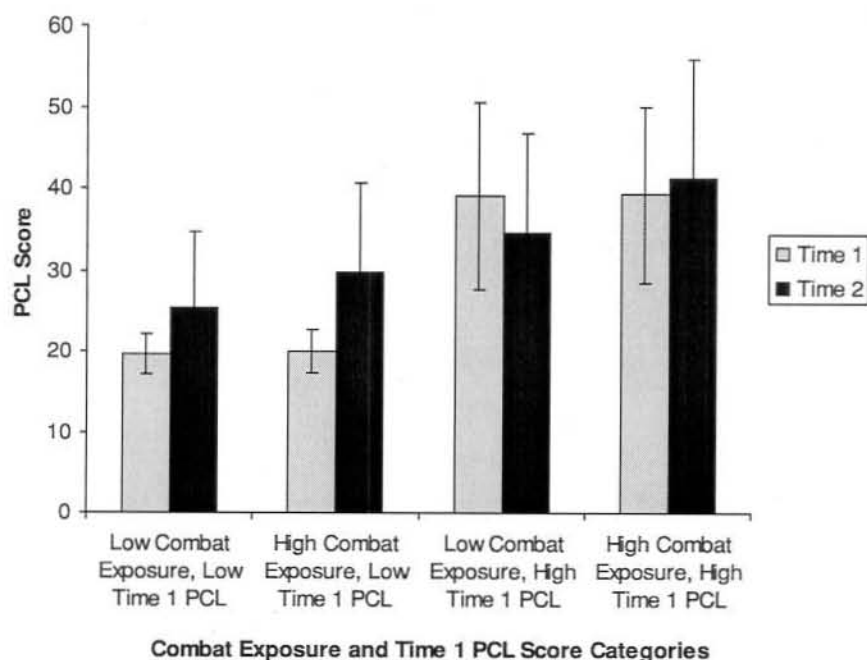
Figure 1. Mean PTSD Checklist (PCL) summary scores (with standard deviations) at Time 1 and Time 2 for categorizations created by median splits of Deployment Risk and Resiliency Inventory Combat Experiences Scale and Time 1 PCL scores.

Predeployment PTSD Symptoms, Stress Exposures, and PTSD Symptom Change Among Deployers

Deployers reported a range of stressors (Table 2) consistent with war-zone participation (e.g., receiving hostile fire) and reflecting concerns about home and family.

Hierarchical regression analysis revealed that for regular active duty soldiers, demographic factors explained 1% of the variance in PCL change scores; predeployment PCL scores contributed an additional 20% of the variance; war-zone stressors and perceived war-zone threat together contributed an additional 19% of the variance; and homefront concerns and postdeployment life events each contributed an additional 1% of the variance in PCL change scores. Post hoc analyses in which homefront concerns and postdeployment life events were entered as Step 3 and war-zone stressors and perceived threat as Step 4 indicated that homefront concerns and postdeployment life events collectively contributed 7% of the variance in PCL change scores beyond demographics and predeployment PCL scores, and war-zone stressors/perceived threat uniquely contributed an additional 14% of the variance.

In the final model (Table 3), taking predeployment PCL scores and all stressors into account, lower predeployment PCL scores and higher scores on each of the DRRI modules (DRRI combat experiences, postbattle experiences, deployment concerns, homefront concerns, postdeployment life events) were each uniquely

and significantly associated with greater pre- to postdeployment increases in PCL scores.

The interaction between predeployment PCL and DRRI combat experiences scores was significant, $B = 0.07$, $SE\ B = 0.00$, $\beta = .24$, $p < .01$. Regular active duty soldiers with more severe PTSD symptoms at predeployment showed differential pre- to postdeployment change in PTSD symptoms according to their level of combat exposure (Figure 1). Soldiers with higher baseline PCL scores, but lower DRRI combat experiences scores showed a greater decrease in PCL scores from baseline to postdeployment, whereas soldiers with higher baseline PCL scores and higher DRRI combat experiences scores showed less change (and a slight increase) in PCL scores from baseline to postdeployment.

For National Guard soldiers, demographic factors explained 1% of the variance in PCL change scores; predeployment PCL scores contributed an additional 5% of the variance in PCL change scores; war-zone stressors and perceived threat together contributed an additional 21% of the variance in PCL change scores; homefront concerns contributed an additional 4% of the variance; postdeployment stressors contributed an additional 14% of the variance in PCL change. Post hoc analyses in which homefront concerns and postdeployment life events were entered as Step 3 and war-zone stressors and perceived threat as Step 4 indicated that homefront concerns and postdeployment life events collectively contributed 22% of the variance in PCL change scores beyond demographics

Table 2. DRRI Subscale Summary Scores and Three Most Frequently Reported Events Within Each Stress Exposure Measure Among Deployers

Variable	All deployed (n = 774) M, %	SD	Active duty deployed (n = 670) M, %	SD	National Guard deployed (n = 104) M, %	SD	Scale range
DRRI Combat experiences, during deployment, total score, *M, SD*	17.3	10.4	18.3	10.6	10.8	5.7	0–64
Received hostile incoming fire from small arms, artillery, rockets, mortars, or bombs (any), %	97.1		97.9		92.3		
At least a few times per week, %	61.2		67.6		20.2		
Participated in a support convoy (any)	94.8		94.6		96.2		
At least a few times per week, %	34.0		37.0		14.4		
Went on combat patrols or missions (any), %	91.7		91.5		93.3		
At least a few times per week, %	60.6		60.6		60.6		
DRRI Postbattle experiences, during deployment, total score,[a] *M, SD*	7.8	4.0	8.0	4.1	6.3	3.7	0–16
Saw people begging for food, %	96.6		97.9		88.5		
Observed homes or villages that been destroyed, %	77.4		77.6		76.0		
Saw Americans or allies after they had been severely wounded or disfigured, %	58.7		62.8		32.0		
Interacted with enemy soldiers who were taken as prisoners of war, %	42.4		39.3		62.5		
DRRI Deployment concerns, total score, *M, SD*	45.6	10.4	46.0	10.4	42.8	10.3	15–75
"I was concerned that my unit would be attacked by the enemy," agree or strongly agree, %	77.4		78.8		68.3		
"I was afraid that I would encounter a mine or booby trap," agree or strongly agree, %	65.1		64.5		69.2		
"I felt that I was in great danger of being killed or wounded," agree or strongly agree, %	62.4		65.1		45.2		
DRRI Life and family concerns, during deployment, total score, *M, SD*	24.9	7.5	24.5	7.4	27.1	7.5	14–56
"The well being of my family or friends while I was away," moderate or great concern, %	54.3		54.8		51.0		
"Missing important events at home such as birthdays, weddings, funerals, graduations, etc," moderate or great concern, %	53.0		52.8		54.8		
"My inability to help my family or friends if they had some type of problem," moderate or great concern, %	51.9		52.4		49.0		
DRRI Postdeployment Stressors, summary score,[a] *M, SD*	1.0	1.4	1.0	1.4	1.3	1.3	0–17
Experienced the death of someone close, %	14.4		13.0		23.1		
Gone through a divorce or been left by a partner or significant other, %	11.8		12.0		10.6		
Emotionally mistreated (e.g., shamed, embarrassed, ignored, or repeatedly told I was no good), %	10.5		10.9		7.7		
Unemployed and seeking employment for at least 3 months, %	2.9		0.1		20.4		
Experienced a mental illness or life-threatening physical illness of someone close to me, %	8.4		7.5		14.4		

Note. DRRI = Deployment Risk and Resilience Inventory; AD = active duty; NG = National Guard.
[a]Because the type of stressors most commonly experienced differed between AD and NG, the three most prevalent stressors for each are presented.

Table 3. Summary of Hierarchical Multiple Regression Analysis (Final Models) for Time 1 PCL Summary Scores and Stressor Exposure Variables Predicting Pre- to Postdeployment Change in PCL Summary Scores in Regular Active Duty Deployers and Activated National Guard Deployers

Variable	Active duty deployed ($n = 670$)			National Guard deployed ($n = 104$)		
	B	SE B	β	B	SE B	β
Demographics:						
Age, years	0.10	0.08	0.04	0.25	0.12	0.16*
Gender (female = 1)	2.25	1.49	0.05	–	–	–
Education, years	0.25	0.33	0.02	−0.21	0.60	−0.03
Time 1 PTSD symptoms:						
Time 1 PCL summary score	−0.61	0.33	−0.58***	−0.55	0.11	−0.40***
War-zone stress:						
DRRI Combat experience, summary score	0.18	0.05	0.15***	1.01	0.31	0.45***
DRRI Postbattle experience, summary score	0.34	0.13	0.11**	−0.18	0.43	−0.05
DRRI Deployment concerns, summary score	0.37	0.04	0.29***	0.05	0.11	0.04
Homefront stress:						
DRRI Life and family concerns, summary score	0.19	0.06	0.11***	0.22	0.14	0.13
Postdeployment stress:						
DRRI Postdeployment life events, summary score	0.98	0.31	0.10**	3.92	0.79	0.41***

Note. PCL = PTSD Checklist; DRRI = Deployment Risk and Resilience Inventory. The sample size varies slightly across observations due to missing data. B and β are the unstandardized and standardized parameter estimates, respectively, for each covariate in the final model (following Step 5). The negative B and β coefficient for Time 1 PCL reflects that higher predeployment PTSD symptoms were associated with less change in PTSD symptom severity from pre- to postdeployment. Higher, more positive B and β coefficients for stressor measures reflect stronger associations between stressor severity and PTSD symptom severity, with higher levels of stressor severity associated with more adverse PTSD outcome.
*$p < .05$. **$p < .01$. ***$p < .001$.

and predeployment PCL scores, and war-zone stressors/perceived threat uniquely contributed an additional 17% of the variance.

In the final model (Table 3), taking predeployment PCL scores and all stressors into account, increases in PTSD symptom severity from pre- to postdeployment in National Guard soldiers were uniquely and significantly associated with older age, lower predeployment PCL scores, and higher DRRI combat experiences and postdeployment life events scores.

None of the interactions between predeployment PCL scores and DRRI stress exposure variables reached statistical significance.

DISCUSSION

This prospective cohort study found that military deployment to Iraq is associated with pre- to postdeployment increases in PTSD symptoms, even after adjusting for baseline levels of PTSD symptoms. Nondeployed soldiers did not show symptom increases, suggesting that pre- to postdeployment increases could not be attributed to nonspecific factors inherent to military life. By prospectively assessing PTSD symptom levels prior to deployment and linking pre- and postdeployment deployment responses within each participant, we avoided retrospective report biases pertaining to predeployment functioning and accounted for individual variation in baseline symptoms. A prospective study of UK

service members likewise found that combat exposure was associated with postdeployment PTSD symptoms after adjusting for baseline PTSD symptoms (Rona et al., 2009). Our findings, combined with those of Rona et al. (2009), provide strong evidence that deployment to a contemporary war zone results in adverse mental health consequences that cannot be explained by preexisting symptoms.

Among deployed soldiers, those activated from National Guard status showed greater increases in PTSD symptoms from pre- to postdeployment as compared with regular active duty soldiers. The absolute severity of PTSD symptoms and rates of PTSD screening cases differed little among deployed National Guard and regular active duty soldiers at postdeployment, but National Guard soldiers reported less severe PTSD symptoms at predeployment than regular active duty soldiers. Activated reservists have comprised a large proportion of deployed U.S. forces. Because of the potential for greater occupational disruption, less consistent opportunity for combat training, and the differing missions of National Guard components, the postdeployment health of reservists has surfaced as a particular concern. Our results support this concern.

It is also possible that findings associated with duty status reflect that, relative to soldiers who remained on active duty, National Guard soldiers were assessed after more time had transpired since their return from Iraq, when differences between regular

active duty and National Guard/Reserve personnel may be more pronounced (Milliken et al., 2007). Although interval durations between Iraq return and assessment were not significantly correlated with PTSD outcome in either regular active duty or activated National Guard soldiers, the restricted intervals within each of the duty status samples leave open the possibility that differences between regular active duty and National Guard are artifacts of the sampling timeframe. Our findings, however, are not unique. In a UK sample, Browne et al. (2007) found that problems at home (primarily measured after deployment) were more strongly associated with PTSD symptoms than events in Iraq among reservists but not among "regular" duty personnel.

Relationship of Predeployment to Postdeployment Symptoms Among Deployers

The relationship between preexisting PTSD symptoms and change in symptom levels over the deployment was complex. When considered independently of deployment-related stressors, less severe preexisting PTSD symptoms were associated with greater increases in PTSD symptoms, possibly reflecting a statistical artifact in which scores in the lower end of the scale had greater potential to increase than scores nearer to the top end of the scale. It may also be that National Guard soldiers, who reported less severe baseline symptoms than regular active duty soldiers, were more vulnerable to war-zone stress than regular active duty soldiers; however, this explanation is unlikely, as the inverse relationship between baseline symptom severity and longitudinal increases in symptom severity occurred in both regular active duty and National Guard deployed subsets. A third explanation draws from the concept of "stress inoculation," which purports that stressful experiences can build the mastery needed to cope with subsequent stress (Epstein, 1983). By this account, prior stress exposures (as reflected by elevated baseline symptom severity) might have helped soldiers cope with subsequent deployment-related stressors. Cabrera et al. (2007), for example, found that service members with greater exposure to childhood adversity appeared less reactive to higher levels of Iraq combat. Prior stress exposure may also sensitize people to subsequent stress, particularly when the earlier exposure is associated with PTSD symptoms (Breslau et al., 2008), but the full set of circumstances that lead to inoculation versus sensitization remains uncertain.

Our findings revealed an interaction between predeployment PCL scores and combat intensity. Consistent with prior research indicating that exposure to lower levels of combat stress can result in positive mental health changes (Schnurr, Rosenberg, & Friedman, 1993), soldiers with (mild to moderately) elevated baseline symptom severity and low combat exposure showed some reduction of PTSD symptom severity from pre- to postdeployment. In contrast, when exposed to more-extensive combat, PTSD symptom severity changed little from pre- to postdeployment. These

findings suggest that until more effective and specific stress inoculation strategies can be developed, the amount of protection afforded by prior stress exposures (including combat) is limited. Moreover, the results suggest that any protection that does result from stressful predeployment experiences can be overridden by higher levels of subsequent combat exposure.

It is also noteworthy that high levels of combat were more detrimental among soldiers who reported more severe PTSD symptoms at baseline. This finding is particularly pertinent in the context of multiple deployments that will result in sustained PTSD symptoms among some service members. Service members with more pronounced PTSD symptoms prior to deployment will warrant more intensive mental health interventions aimed at managing existing symptoms prior to deploying and/or should be given the opportunity to recover prior to engaging in intensive combat.

Relationships Between Stress Exposures and PTSD Symptom Change

Consistent with previous cross-sectional work (Dohrenwend et al., 2006; Hoge et al., 2004; Kulka et al., 1990), we found that higher levels of stress during deployment translated to greater increases in PTSD symptom severity following deployment. However, associations between stressors and PTSD symptom change differed somewhat among regular active duty and activated National Guard soldiers. In both groups, war-zone stress contributed significantly to PTSD symptom severity increases beyond homefront and postdeployment stress, but PTSD severity increases were associated unexpectedly with a broader range of war-zone stressors among regular active duty, compared with National Guard, soldiers. Only combat experiences contributed significantly to symptom severity increases among activated National Guard soldiers, whereas postbattle experiences and threat perception were more strongly associated than combat experiences with symptom increases among regular active duty soldiers. This finding cannot be attributed to increased combat exposure among National Guard members, as deployed regular active duty soldiers reported more combat exposure than deployed National Guard soldiers, but may reflect in part differences in the types of noncombat (i.e., postbattle) war-zone events experienced by the two groups.

Homefront concerns experienced during deployment were significantly associated with PTSD severity increases only among regular active duty soldiers. Conversely, postdeployment life events more strongly predicted the outcomes of National Guard soldiers, despite the few postdeployment stressful life events (less than two events) reported by both regular active duty and National Guard soldiers. The stronger association of postdeployment stressful life events with PTSD symptom outcomes among National Guard soldiers possibly reflects the different contexts into which these groups return. For example, in our sample, over 20% of National Guard, compared with <1% of regular active duty

soldiers, faced unemployment when they returned; twice as many National Guard soldiers were confronted with the illness of someone close to them. Regular active duty soldiers also return to a social environment characterized by recently shared deployment experiences, an occupational context notable for continuity of military-relevant duties and organizational structure, and a readily accessible health care system. In contrast, National Guard soldiers deploy from predominantly civilian lifestyles with greater potential for deployment-related disruption, have less frequent contact with unit members with whom they shared deployment experiences, and may not have the same access to health care (Milliken, Auchterlonie, & Hoge, 2007), suggesting that early outreach may be particularly beneficial for National Guard soldiers.

Consistent with previous work (Iversen et al., 2008; King et al., 1999; King et al., 2008), the perception of threat during deployment predicted PTSD symptom severity increases independently of war-zone events among regular active duty soldiers. The association of event-based measures and subjective appraisals of threat with increased PTSD symptoms reconfirms conceptualizations of stress that emphasize both the tangible characteristics of stressful events and the individual's perception of the events as threatening (Folkman & Lazarus, 1985). Although not as strongly associated with PTSD symptom increases as war-zone events for regular active duty soldiers, homefront and postdeployment life stress conferred additional risk of adverse outcomes, emphasizing the importance of attending to the broader context of the lives of military personnel, including social and family functioning, financial issues, and reintegration into predeployment environments upon return from deployment.

Limitations and Conclusions

Reflecting the conceptualization of posttraumatic stress reactions as dimensional, we examined PTSD continuously as a severity index rather than as a diagnostic category. Therefore, whereas our findings could document a range of changes in symptom severity as a function of deployment, we did not document clinically assessed diagnostic cases of PTSD. To allow comparison with other large studies of OIF veterans, we reported screening-based PTSD cases. Posttraumatic stress disorder prevalence rates should be interpreted with caution, however, as screening diagnoses may over- or underestimate true prevalence. Because we did not measure the spectrum of stress-related disorders (e.g., depression, non-PTSD anxiety disorders), results may underestimate the full impact of deployment-related stress exposures. Although we assessed war-zone stressors soon after return from Iraq, it is possible that mood state influenced the report of exposures (Wessely et al., 2003; Wilson et al., 2008); however, high correlations between objective indices of combat intensity and self-report (Dohrenwend et al., 2008) suggest that such reporting biases may be minimal.

The results do not generalize to all military personnel. Although sample demographics at enrollment generally reflected those of the deployed Army population, sampling was not population-based and included only one service branch. The National Guard subgroup likewise does not generalize to the broader population of reservists. Compared with Time 2 nonparticipants, participants in the final Time 2 sample reported fewer PTSD symptoms at Time 1 and differed on select demographic variables. Many of the variables in which they differed, however, are interrelated (e.g., older soldiers are more likely to have both deployed previously and retired) and are unlikely to reflect cooperation biases, as few soldiers declined participation. Nonetheless, the presence of PTSD intrusion and avoidance symptoms prior to deployment reduced the likelihood of Iraq deployment among UK military personnel (Wilson et al., 2009). Thus, baseline PTSD symptoms may have spurred some soldiers in our Time 1 sample to opt out of further military service prior to Time 2 assessment, possibly influencing results.

These limitations are offset by the rare availability of prospectively gathered baseline data, within subject comparisons, assessments designed specifically around the deployment, inclusion of a comparison sample well-matched to the deployed sample in military characteristics, and assessment of a broad range of stressors measured on a continuous scale. The results thus provide scientifically rigorous evidence that war-zone deployment leads to increased PTSD symptoms. The multiple determinants of deployment-related increases in PTSD symptoms afford a critical opportunity for prevention programs at both pre- and immediate postdeployment phases. For example, whereas exposure to combat may be an unavoidable aspect of war-zone deployment for many military personnel, the interpretation and regulation of the threat associated with each event is potentially modifiable and can be integrated into prevention skills training prior to deployment. Early intervention following return from deployment tailored to the varied concerns related to the deployment and reintegration will likely help mitigate the longer-term consequences of the deployment. Finally, findings emphasize the importance of continued attention to the concerns of National Guard and Reserve service members.

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